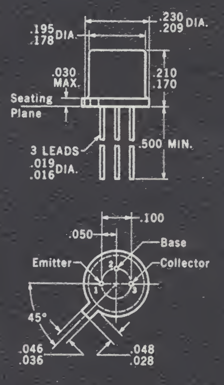
2N3304

PNP HIGH-SPEED SWITCH

SILICON PLANAR EPITAXIAL TRANSISTOR

The **2N3304** is a very high speed PNP silicon epitaxial PLANAR device intended primarily for use in high speed logic application. A 500 mc minimum f_T and a 30 nsec maximum τ_s make it an ideal alternative to germanium devices for applications requiring the greater margin of reliability afforded by its silicon PLANAR construction.

PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-18) outline



NOTES: All dimensions in inches
Leads are gold-plated kovar
Collector internally connected to case
Package weight is 0.43 gram

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

Storage Temperature	**−65°C** to **+200°C**
Operating Junction Temperature	**200°C** Maximum
Lead Temperature (Soldering, 60 sec time limit)	**300°C** Maximum

Maximum Power Dissipation

Total Dissipation at 100°C Case Temperature [Notes 2 and 3]	**0.5** Watt
at 25°C Ambient Temperature [Notes 2 and 3]	**0.3** Watt

Maximum Voltages and Current

V_{CBO}	Collector to Base Voltage	**−6.0** Volts
V_{CEO}	Collector to Emitter Voltage [Note 4]	**−6.0** Volts
V_{EBO}	Emitter to Base Voltage	**−4.0** Volts

ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

SYMBOL	CHARACTERISTIC	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
τ_s	Charge Storage Time [Note 6]		22	30	nsec	$I_C \approx 10$ mA $I_{B1} \approx 10$ mA $I_{B2} \approx -10$ mA
t_{on}	Turn On Time [Note 6]		27	60	nsec	$I_C \approx 10$ mA $I_{B1} \approx 0.5$ mA
t_{off}	Turn Off Time [Note 6]		34	60	nsec	$I_C \approx 10$ mA $I_{B1} \approx 0.5$ mA $I_{B2} \approx -0.5$ mA
h_{fe}	High Frequency Current Gain (f = 100 mc)	5.0	7.0			$I_C = 10$ mA $V_{CE} = -5.0$ V
h_{FE}	DC Pulse Current Gain [Note 5]	30	63	120		$I_C = 10$ mA $V_{CE} = -0.3$ V
h_{FE}	DC Pulse Current Gain [Note 5]	20	50			$I_C = 50$ mA $V_{CE} = -1.0$ V
h_{FE}	DC Pulse Current Gain [Note 5]	15	60			$I_C = 1.0$ mA $V_{CE} = -0.5$ V
V_{CE} **(sat)**	Collector Saturation Voltage		−0.05	−0.15	Volts	$I_C = 1.0$ mA $I_B = 0.1$ mA
V_{CE} **(sat)**	Collector Saturation Voltage		−0.07	−0.16	Volts	$I_C = 10$ mA $I_B = 1.0$ mA
V_{CE} **(sat)**	Collector Saturation Voltage		−0.2	−0.5	Volts	$I_C = 50$ mA $I_B = 5.0$ mA

Additional Electrical Characteristics on page 2

NOTES:

(1) These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.
(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 200°C/watt (derating factor of 2.0 mW/°C); junction-to-ambient thermal resistance of 583°C/watt (derating factor of 1.72 mW/°C).
(4) This rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.
(6) See switching circuit for exact values of I_C, I_{B1} and I_{B2}.

FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
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FAIRCHILD TRANSISTOR 2N3304

ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

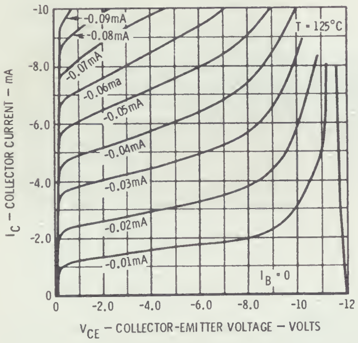
SYMBOL	CHARACTERISTIC	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{FE} (−55°C)	DC Pulse Current Gain [Note 5]	12	33			I_C = 10 mA	V_{CE} = −0.3 V
V_{BE} (sat)	Base Saturation Voltage	−0.7	−0.76	−0.8	Volts	I_C = 1.0 mA	I_B = 0.1 mA
V_{BE} (sat)	Base Saturation Voltage	−0.8	−0.88	−1.0	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{BE} (sat)	Base Saturation Voltage		−1.1	−1.5	Volts	I_C = 50 mA	I_B = 5.0 mA
V_{CE} (sat)(125°C)	Collector Saturation Voltage		−0.09	−0.23	Volts	I_C = 10 mA	I_B = 1.0 mA
I_{CES}	Collector Reverse Current		0.003	10	nA	V_{CE} = −3.0 V	V_{EB} = 0
I_{CES} (125°C)	Collector Reverse Current		0.001	10	μA	V_{CE} = −3.0 V	V_{EB} = 0
C_{ob}	Output Capacitance		1.9	3.5	pf	V_{CB} = −5.0 V	I_E = 0
C_{TE}	Emitter Transition Capacitance		1.8	3.5	pf	V_{EB} = −0.5 V	I_E = 0
BV_{CBO}	Collector to Base Breakdown Voltage	−6.0			Volts	I_C = 100 μA	I_E = 0
BV_{CES}	Collector to Emitter Breakdown Voltage	−6.0			Volts	I_C = 100 μA	I_B = 0
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage [Notes 4 and 5]	−6.0			Volts	I_C = 10 mA	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	−4.0			Volts	I_E = 100 μA	I_C = 0

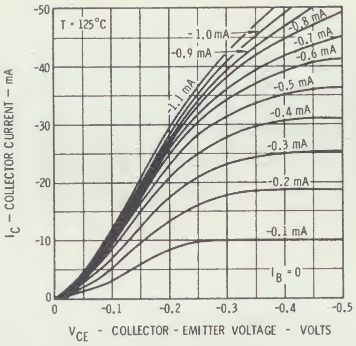
TYPICAL COLLECTOR AND BASE CHARACTERISTICS*

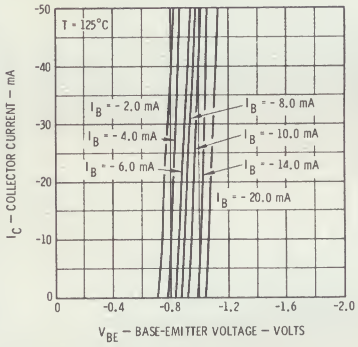
ACTIVE REGION

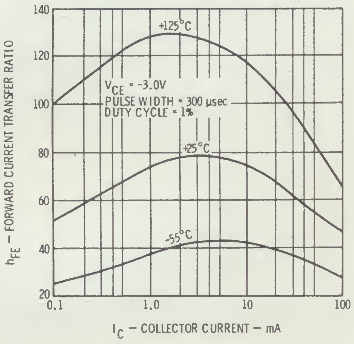
SATURATION REGION

PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT

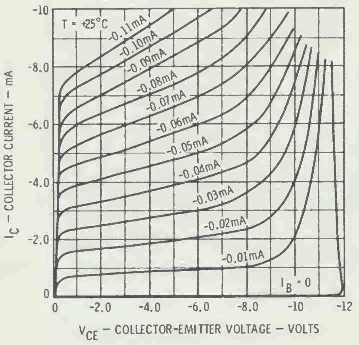


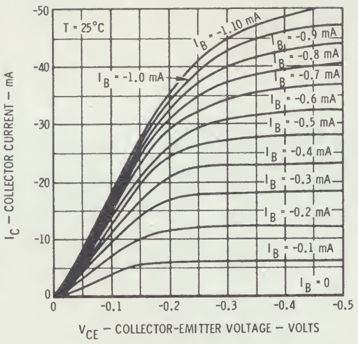


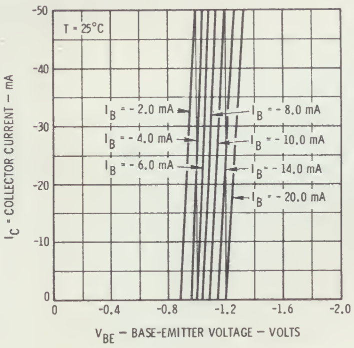


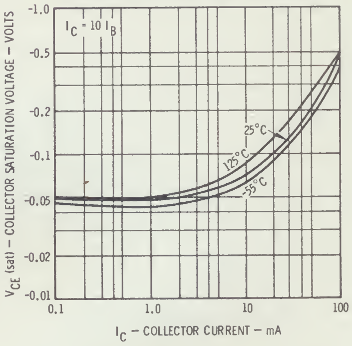


COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

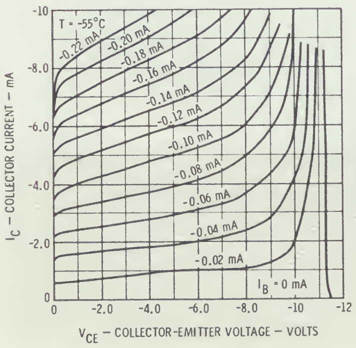


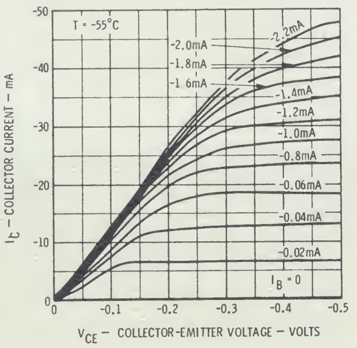


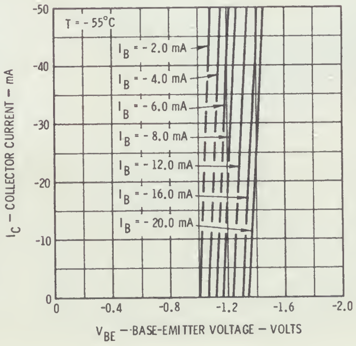


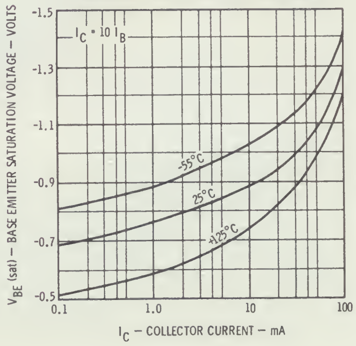


BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



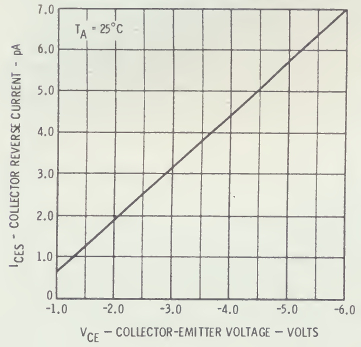




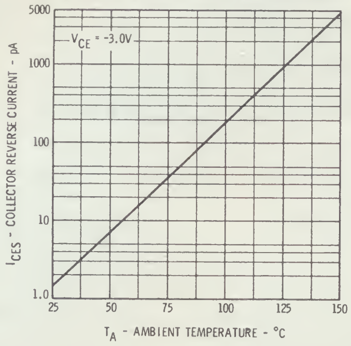


* Single family characteristics on Transistor Curve Tracer.

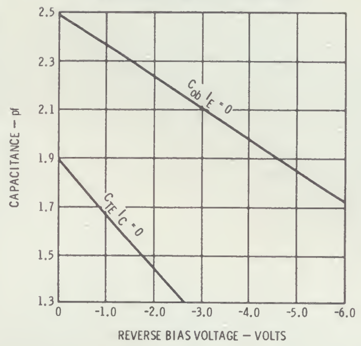
COLLECTOR REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



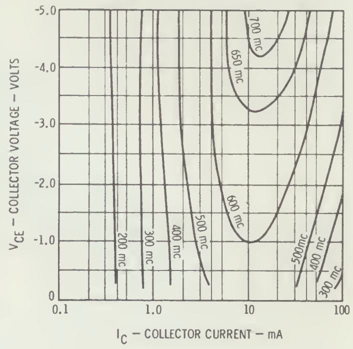
COLLECTOR REVERSE CURRENT VERSUS AMBIENT TEMPERATURE



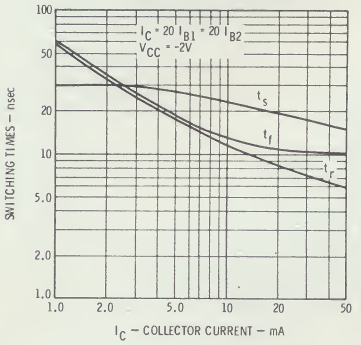
INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



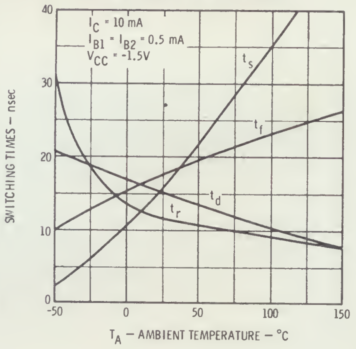
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



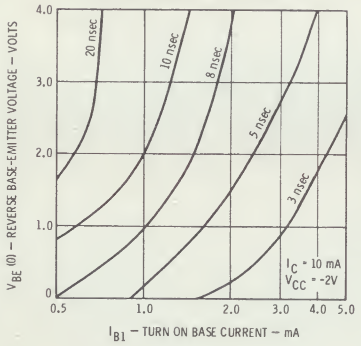
SWITCHING TIMES VERSUS COLLECTOR CURRENT



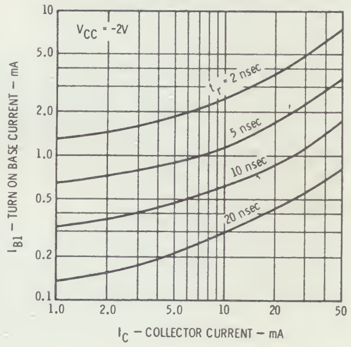
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



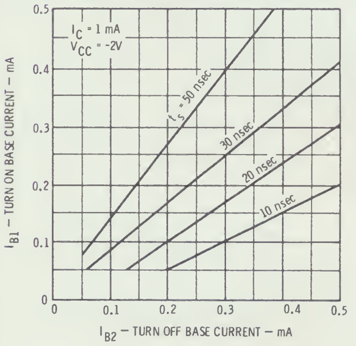
DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE



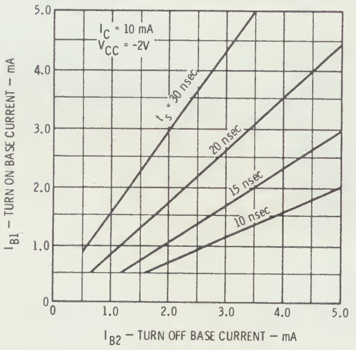
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENTS



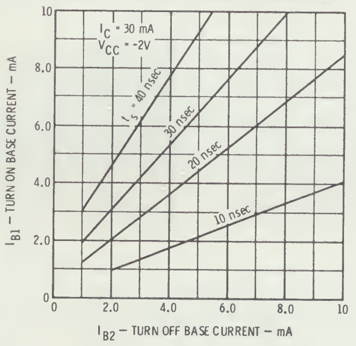
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



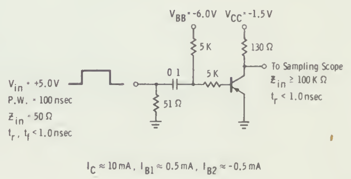
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



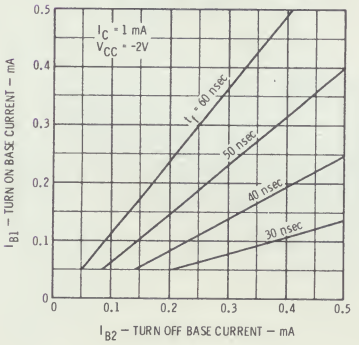
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



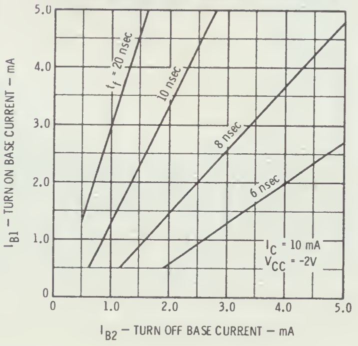
TURN ON AND TURN OFF TEST CIRCUIT



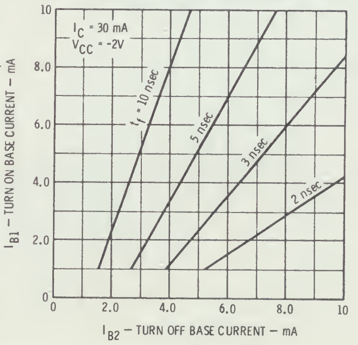
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



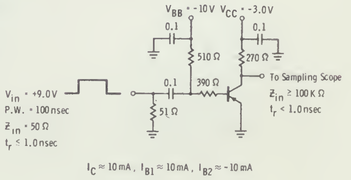
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS

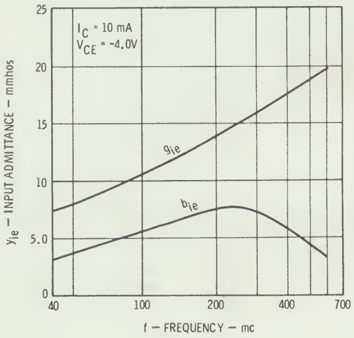


CHARGE STORAGE TIME TEST CIRCUIT

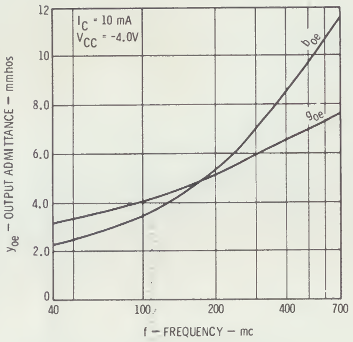


TYPICAL COMMON EMITTER "Y" PARAMETERS

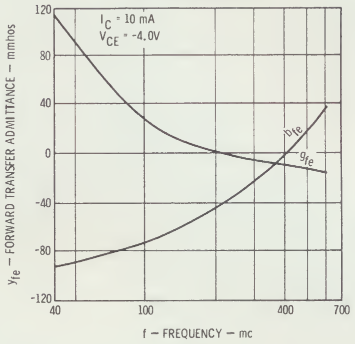
INPUT ADMITTANCE VERSUS FREQUENCY-OUTPUT SHORT CIRCUIT



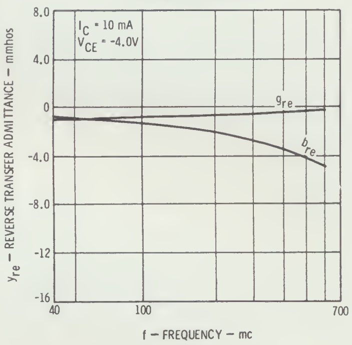
OUTPUT ADMITTANCE VERSUS FREQUENCY-INPUT SHORT CIRCUIT



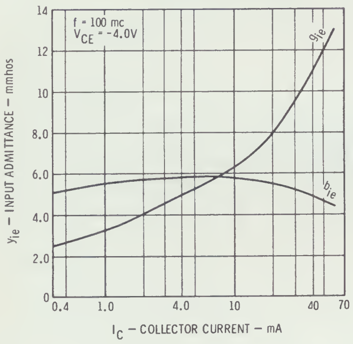
FORWARD TRANSFER ADMITTANCE VERSUS FREQUENCY-OUTPUT SHORT CIRCUIT



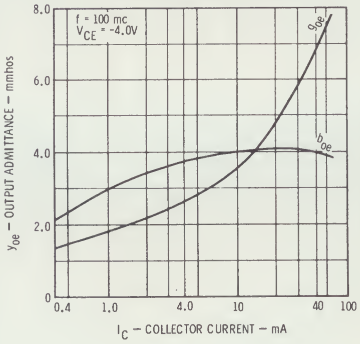
REVERSE TRANSFER ADMITTANCE VERSUS FREQUENCY-INPUT SHORT CIRCUIT



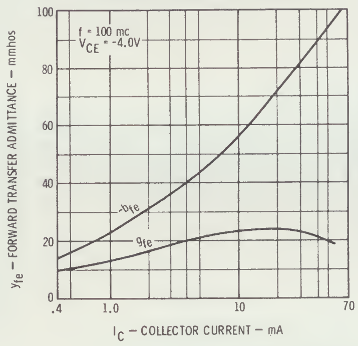
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT



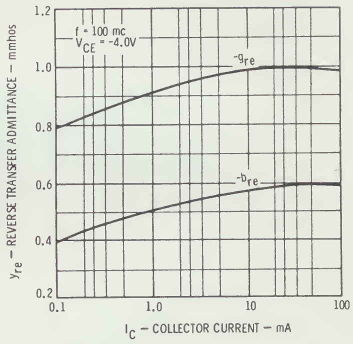
OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT



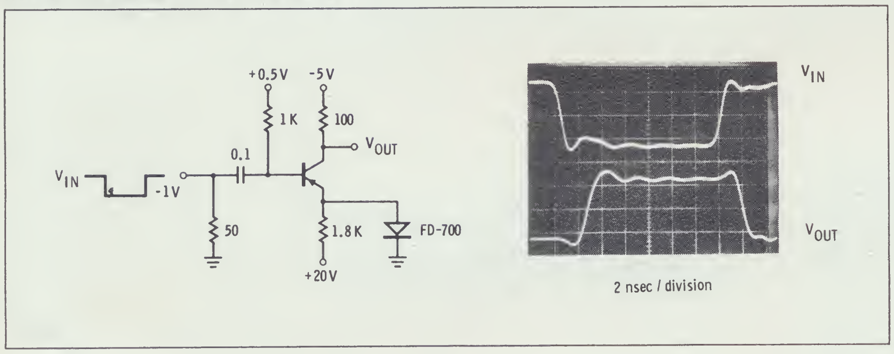
FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT



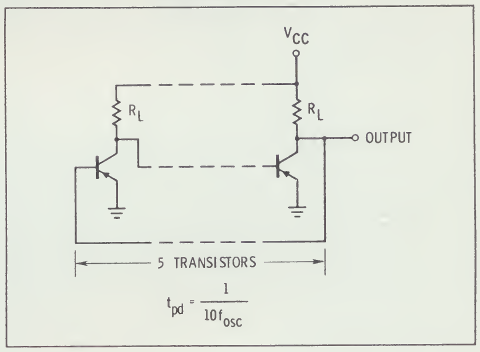
REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT



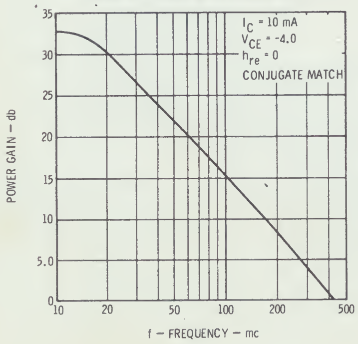
NON SATURATED SWITCHING PERFORMANCE



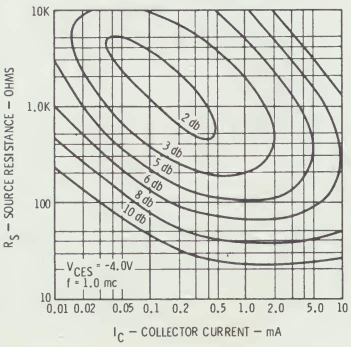
FIVE STAGE RING OSCILLATOR FOR MEASUREMENT OF PROPAGATION DELAY



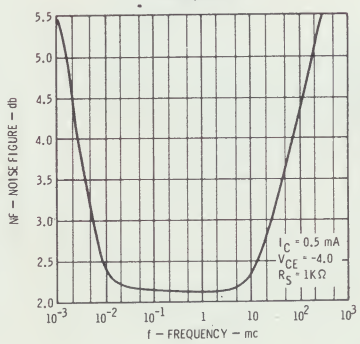
IDEALIZED SMALL SIGNAL POWER GAIN VERSUS FREQUENCY



NOISE FIGURE VERSUS SOURCE RESISTANCE AND COLLECTOR CURRENT



NOISE FIGURE VERSUS FREQUENCY



PROPAGATION DELAY TIME VERSUS COLLECTOR SUPPLY VOLTAGE